THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

Faculty of Engineering and Technology

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

INSTITUTIONAL BASED PROGRAMME

DIPLOMA IN MECHANICAL ENGINEERING (PLANT OPTION)

PLANT ELECTRICAL II

YEAR III SEMESTER I

SERIES: NOVEMBER 2011

TIME: 2HOURS

INSTRUCTION TO CANDIDATES

You should have the following for this examination

- *Scientific Calculator*
- *Answer booklet*

This paper consists of **FIVE** questions in two sections; A and B.
Answer question **ONE** and any other **TWO** question from section B
Maximum marks for each part of a question are as shown.
This paper consists of **FOUR** printed pages

SECTION A (Compulsory)

QUESTION ONE

a) Identify and match the electric heating methods described below: (7mks)

Description	**Electric Heating Method**
The material or charge to be heated is treated as a resistance and charge is passed through it.	
Electric current is passed through a resistance element which is placed in an electric oven or cylinder.	
Electric heating comprising suitable insulated chambers with provision for ventilation used for heat treatment of metals.	
High voltage is applied across air gap through the carbon or graphite electrodes in such a way that electric current passes the body of the charge.	
Electric heating which contains no iron core hence no continuous path for the magnetic flux.	
Electric heating method that can take place in a vacuum.	
Electric heating method to heat bad conductors of heat.	

b) Explain the two methods of temperature control of resistance furnaces. (2mks)

c) If P is the power input, and H is the heat dissipated by radiation, show by first principle that as per Stephan's law of radiation that:

$$\frac{l}{d^2} = \frac{\pi V^2}{4 l \rho}$$ (3mks)

d) Explain why industrial tariffs include a charge per KVA of maximum demand. (1mk)

e) It is usual for power, factor correction capacitors to be near as possible to the equipment which causes low lagging power factor. Explain. (2mks)

f) A factory has a maximum demand of 200KVA when operating a power factor of 0.7 lagging. If power factor improvement equipment is installed to give a power factor of 0.95, calculate the annual saving in the electricity charge? What will be the total electricity charge in one year after the power factor has been improved if the factory has a load factor of 50%. The tariff is Kshs. 8.75 per kVA of maximum demand per year plus 0.5 per unit consumed. (5mks)

SECTION B (Answer any two questions in this section)

QUESTION TWO

a) Define heating. (1mks)

b) Explain the principle of induction heating. State applications of induction heating.

(3mks)

c) State any four advantages of induction heating over conventional methods of heating in industries.

(4mks)

d) Explain four advantages of electric heating. (4mks)

e) An insulating material 2cm thick and 200cm^2 in area is to be heated by dielectric heating. The material has relative permittivity of 5 and power factor of 0.05. Power required is 400W and frequency of 40MHz. Calculate the voltage and current that will flow through the material. If the voltage is limited to 700V, calculate the frequency to get the same loss. (4mks)

f) State four applications of dielectric heating. (4mks)

QUESTION THREE

a) Define:
   i. fixed costs
   ii. running/operating costs
   iii. two part tarrif

b) Give examples of each of the above. (6mks)

c) State factors influencing costs and tariffs of electric supply. (3mks)

d) Using a well labeled diagram, explain the operation of the direct arc funaces (5mks)

e) A resistance oven employing nichrome wire is to be operated from 220V single phase supply and is to be rated at 16kW. If the temperature of the element is to be limited to 1,170^{o}C and average temperature of charge is 500^{o}C, calculate the diameter and length of the element wire. (take radiating efficiency=0.57, emissivity=0.9, specific resistance of nichrome=109×10^{-8}. (6mks)

QUESTION FOUR

a) A factory takes a load of 20kW at 0.85 power factor lagging for 2500hours p.a. and buys energy on tariff of Kshs.150 per kVA plus Kshs. 6 per kWh consumed. If power factor is improved to 0.9 lagging by means of a capacitor costing shs. 525 per KVA and having a power factor of 100W per KVA, Calculate the annual saving affected by their use. Allow 8% p.a for interest and depreciation on the capacitors. (7mks)

b) Explain the difference between core type and coreless induction furnace heating. (3mks)
c) Explain two methods of heat transfer. (2mks)
d) State five requirements for a good heating element. (5mks)
e) State three limitations of low power factor. (3mks)

QUESTION FIVE

a) Explain the difference between load factor and power factor. (2mks)

b) A 415kV three phase, 50Hz motor of 150kW output operates on full load at a lagging power factor of 0.707 with efficiency of 85.6%. Calculate the rating of capacitor required to improve the power factor to 0.98 lagging and its capacitance per phase if it is delta connected. If the maximum demand charge in the tariff is shs. 8.00 per kVA per annum. What is the annual reduction in the cost of electricity?

(6mks)

c) With the aid of a circuit diagram and waveforms, explain the term phase control as applied to controlled rectification. (7mks)

d) The load survey of a small town gives the following categories of expected load.

Type	Load in kW	% Diversity factor	Group Diversity factor
Residential lighting	1000	60	3
Commercial lighting	300	75	1.5
Street lighting	50	100	1.0
Domestic power	300	50	1.5
Industrial power	1800	55	1.2

Calculate the KVA capacity of the sub-station assuming the station power factor of 0.8 lagging. (5mks)